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THE USE OF LUMBER ON CALIFORNIA FARMS

BY
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THE USE OF LUMBER ON CALIFORNIA FARMS

By MERRITT B. PRATT

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This circular aims to give the farmers of California information regarding the properties of different woods available in the state, and the relation of these properties to different uses made of lumber on the farm. It is introductory to plans for farm structures prepared by the Division of Agricultural Engineering, University Farm, Davis, California. These plans, which can be borrowed without charge by any farmer in California by writing to the Division of Agricultural Extension of the University of California, are designed to meet the demands made for farm buildings in this state.

CONSIDERATIONS IN PLANNING FARM STRUCTURES[1]

Low Initial Cost.—The first object sought in any farm structure, whether it be a house, barn, silo or hog-pen, is to provide in a suitable manner for all purposes necessitating its erection. In most constructions, however, a wide variation in costs is possible, ranging from a too low first cost, which results in unsatisfactory construction, to an unduly high cost, which places too great a tax on the farm business for the use of the structure.

In every structure it is well to keep the first cost as low as consistent with proper construction, bearing in mind that the first cost of a structure influences to some extent the resulting upkeep cost. That is, a well-built structure may amount to relatively more in original cost than a poorly constructed one, but the greater cost may be justified in view of subsequent reduced upkeep cost.

Structures are not in themselves direct producers of income but rather contribute as aids to production. The less the expenditure involved in structures, the smaller are the charges to be met by the business.

For the use of structures the farm must pay for upkeep—repairs, replacement and protection—and the overhead charges of interest on all money spent upon the structure. As these charges must be met by the sale of products, the lower the charges the better do the structures meet the need for which they were erected.

Suppose a farmer plans the erection of certain buildings, and two kinds of structures are possible, one costing $1200 and the other $5000. Assuming the more costly is longer lived, the detailed annual charges which the farm must meet for the use of these buildings will be about as follows:

6 per cent interest on the money invested.
4 per cent of original cost for repairs of the $1200 buildings.
3 per cent of original cost for repairs of the $5000 buildings.
3 per cent of original cost for depreciation of the $1200 buildings.
2 per cent of original cost for depreciation of the $5000 buildings.

This means a total annual charge for the use of the buildings of:
$124 for structures costing $1200.
$393 for structures costing $5000.

[1] Prepared by Richard L. Adams of the Division of Agronomy. Photos 1, 2, 3, 4, and 5 by Professor R. L. Adams.

If the size of the ranch is 40 acres, each acre will be called upon to bear its pro rata of the annual charge to the extent of:

$3.10 for the $1200 buildings, as against
$9.82 for the $5000 buildings.

Low Upkeep Cost.—The amount of painting, replacement, and repairs varies with different structures, and constitutes an annual upkeep factor to be borne in mind in planning structures. It is desirable to determine which factor shall rule: a low original cost with resulting high annual upkeep cost; or the reverse, a relatively high original cost with a correspondingly low annual charge for maintenance. In every instance, upkeep cost should be as low as is consistent with the original cost and use of a structure.

Factors Determining Type of Construction.—The type of construction is determined by the nature of the use to which the structure is to be put and the local climatic condition.

A horse barn, for instance, must combine qualities different from those demanded of a warehouse for the storage of grain. The latter must not include to any extent ventilation, freedom from drafts, sanitary convenience, comfort or warmth—qualities very necessary in a structure designed for the protection of stock. A plan for a ditch structure must consider stability, permanency, water tightness, safety and low initial cost. Ditch structures for sandy land should be of somewhat different construction from those in heavy clay soil due to the greater liability of erosion and seepage.

A portable field shelter for stock will necessitate light construction to permit moving it from place to place. Hay barns will vary in the degree of stability to be provided, depending on whether the hay is to be stored on the ground or in an overhead mow, and on the exposure to wind. Bridges for use of tractors demand heavier construction than for small team loads. The man whose dairy is to be permanent will usually favor a more substantial silo than he who is embarking in dairying as an experiment and may later conclude to eliminate cows.

As to the difference in construction necessitated by climatic conditions, one need only compare the widely different conditions for stock protection to be met, for instance, in Humboldt County, having an annual mean rainfall of 38 inches, 128 rainy days, 88 clear days, and temperatures rising and falling between 30° and 74°, with the Imperial Valley with less than 3 inches of rainfall, 11 rainy days, 312 days of sunshine annually, and temperatures of from 25° to 114° F. The kind of protection to be provided against the cold and wet of the rainy season and the heat of the dry season varies greatly in the two

sections, while the life of building materials will not be the same under two such widely different environments.

ADAPTABILITY OF WOOD FOR FARM USE

When the type of farm structure suitable for the demands to be made upon it is determined, there follows a consideration of the materials for its construction.

Under California conditions wood is the favorite farm building material because of its suitability, reasonable cost and availability. Moreover, the working up of lumber is best understood by the average man, the left-overs can be utilized for odd jobs or for fire wood, while second-hand material has a substantial value for many purposes around the farm.

All factors considered, the farmer finds wood the best all-around material for the majority of farm uses, and therefore it is important that he should know something of the various woods available, their suitability for farm uses, and how to buy intelligently for a definite purpose.

SUITABILITY OF WOOD

Not all Woods Have the Same Properties.—In general, wood is strong relative to its weight, readily shaped with tools, light and easy to handle, readily secured, and economically transported as compared to other materials, but in particular some woods possess properties such as durability, strength and stiffness to a greater degree than others, which fit them for specific uses. For example, Douglas fir is unexcelled where strength is the main factor, and redwood where durability is required. If Douglas fir were used for irrigation boxes, however, and redwood for heavy bridge timbers, it is probable that both woods would prove unsatisfactory because of the failure to put them to the use for which they were best suited.

The diversified climatic conditions of California call for considerable discretion in the choice of species. Lumber exposed to the sun in hot, dry sections tends to warp and check. A soft wood such as redwood, western yellow pine or sugar pine is more suitable in such cases than a harder wood like Douglas fir, which tends to check when exposed to the direct rays of the sun. Hemlock and white fir are satisfactory in a hot section if thoroughly dried, but if green, are most unsatisfactory. In all climates durable woods should be used whenever the lumber comes in contact with the ground, or is used in a damp or wet location.

As a guide in the selection of the right wood for a particular use, there is given later (p. 108) an account of the properties of the woods most available to the California farmer.

Some Cases where Wood is Preferable.—Wood is often wrongly displaced on the farm for uses for which it is better adapted than any other material. Horse corrals are often fenced with barbed wire, and as a result, stock are frequently injured by running against it when frightened. Floors in horse stalls should always have a wood covering, even if there is a concrete base, for the sake of warmth and prevention of injury to the feet of stock through stamping. Wooden

Fig. 1.—Attractive buildings are an asset to any farm. The California farmer has his choice of a variety of woods which embrace all the structural requirements for attractive and serviceable farm building.

pipe is often better than any other material for ditch structures, especially where there is a likelihood that there will be an expansion of the ditch system in the future. In that case the wooden structure could be much more easily and cheaply altered than if built of concrete.

Recent experiments by the Iowa Agricultural Experiment Station[2] with hog houses made of wood and metal showed that the range of temperature was nearly 75 per cent greater in the metal house which was much hotter at noon and cooler at night. The increased range

[2] Bulletin 152, Iowa Agricultural Experiment Station.

of temperature in the metal houses makes it evident that they are less desirable than wooden structures as far as the conditioning of the stock is concerned.

Knowledge of Lumber Grades Important.—The best and safest use of wood comes from a knowledge of not only the kinds but the grades of lumber in relation to the use which is to be made of it. The farmer who bought lumber at $30 per thousand to cover his hay stack, could probably have secured the same protection had he purchased a cheaper grade of boards at $25 per thousand. On the other hand, he would have made a mistake had he used the cheap grade of boards

Fig. 2.—An implement shed, even under California conditions, well warrants the expenditure for lumber by lengthening the life of farm implements.

for his corral fence which requires material free from serious defects to withstand the sudden shocks to which it is frequently subjected. In these instances, an idea of lumber grades would have prompted a better selection of material for the use.

Basis of Lumber Grades.—Lumber is separated into various grades to make it suitable for different classes of consumers, and to enable manufacturers to maintain a uniformity of production. Grades are determined by the number, size and location of defects as is shown in the table of grades given for Douglas fir and redwood on page 98. Lumber with practically no defects is of the highest grade and is the most valuable, while lumber which has many defects is of poor quality and brings a relatively lower price.

The following defects are those chiefly recognized in the grading of lumber: (1) *Knots.* These are classified according to their form, size, soundness and the firmness with which they are held in place. (2) *Pitch pockets.* The number and size of the pitch pockets, which are openings between adjacent layers of growth containing more or less pitch, is an important consideration in fixing the grade of Douglas fir and western yellow pine lumber, which contains more or less pitch. (3) *Shake.* A separation of the growth layers of the tree presumably due to the swaying action of the wind, causes shake, which seriously reduces the quality of the wood when converted into structural

Fig. 3.—Lumber enters largely into the equipment of California poultry plants.

materials. (4) *Stain.* Blue stain, which is commonly found in pine lumber, is caused by certain low forms of plant life called fungi, the activity of which produces discoloration in the sapwood. It does not injure the strength of the wood, but is considered a defect because it detracts from the bright, clean appearance of the board. (5) *Rot.* Certain fungi attack the wood substance and break down the structure until the wood becomes rotten. In Douglas fir, rot is indicated by a decided softness of the wood where it is discolored, or by small white spots resembling pin worm holes.

Relation of Grade to Use.—Lumber is used either in its entirety or is resawed into new sizes. The greater part falls into the first

class, as dimension, which is used for studding, joists, sills, and rafters; and boards, which are used for siding, sheathing, partitions and other construction purposes. Both of these classes of material use lumber in the form and size in which it was first manufactured. Lumber included in the second class embraces the cutting grades which find their largest use in factories where they are sawed into sash and door stock, interior finish and box shook.

REASONABLE COST OF LUMBER

How Lumber is Generally Sold.—Lumber is generally quoted by dealers in terms per thousand feet board measure, the common abbreviation for 1000 feet board measure being "M" ft. B. M. The unit by which lumber is reckoned is the board foot, which is a square foot one inch thick. Lumber less than one inch thick is figured as if one inch.

To obtain the number of board feet in a piece of lumber, multiply together the thickness and width in inches, divide the product by 12 and multiply the result by the length in feet.

Examples:

Pieces	Size	Length	Contents in board feet
1	2 × 8	30	40
1	4 × 10	18	60
1	10 × 10	36	300

Average Mill Prices.—Statistics show that lumber prices based on the figure obtained by the manufacturer over the entire country were 10 per cent less in 1915 than in 1906, an actual loss in the period which has marked an average increase of 33 per cent in the price of other commodities. In 1906, fifty bushels of wheat would purchase 1,200 feet of No. 1 sheathing, while in 1916 the same amount of wheat would purchase 2,800 feet of the same material. A comparison of the prices of different kinds of building materials from 1912 to 1916 shows an advance of 32.6 per cent for Portland cement, 17.3 per cent for brick and 63.5 per cent for steel, while the price of lumber advanced only 0.6 per cent during this period for all classes of consumers.

Retail Prices.—The average price obtained by country dealers is from $2.50 to $4 more per thousand feet than that received by city dealers. This is partially due to the higher cost of merchandising and distribution of small amounts of lumber. The higher average

price in country yards is also influenced by the better quality of stock demanded by the farmer, and the higher gross profits made by the country dealer due to lack of competition.

Figures obtained in a recent study made by the U. S. Forest Service[3] showed that farmers in the middle West paid an average price of $31–$32 per thousand feet for lumber in the period from 1912 to 1915. This figure is probably somewhat high for California, especially in the interior valleys, because of the ready accessibility of a variety of woods, and the number of competing yards.

Fig. 4.—Lumber is the prevailing material used in the construction of swine-farrowing pens.

In considering retail prices, the effect of quality should be kept in mind. For finish, flooring, tank stock and other uses where the upper grades are necessary, the cost is high in comparison with the lower grades because of the choice qualities of the lumber which fit it for special purposes.

The relation of grade and price is shown in the following tabulations which give the basis for some of the principal grades made for Douglas fir and redwood, and the influence which quality exerts on price. The range given is that which existed in yards in the Sacramento Valley in January, 1917.

[3] Report No. 114, U. S. Dept. of Agriculture, Some Public and Economic Aspects of the Lumber Industry.

Grades	Basis of grades	Approximate difference in prices per M between grades
Douglas Fir—		
No. 1 vertical grain flooring, 3, 4 and 6 inch	Each piece must have perfect edges and be free from defects. Angle of grain must not be less than 45 degrees	
No. 2 vertical grain flooring, 3, 4 and 6 inch	Admits of a few, small close pitch pockets, or equivalent defects	$5 cheaper than preceding grade
No. 2 and better flat grain flooring, 3, 4 and 6 inch	Flat grain. Admits of slight defects such as small knots and pitch pockets	$5 cheaper than preceding grade
No. 3 clear flooring, siding and rustic	Admits of considerable defect such as checks, knots and pitch pockets	$2.50 cheaper than preceding grade
Timbers, 4 × 4 and larger	Must be well manufactured and free from checks and knots which will weaken the piece	$5 cheaper than preceding grade
No. 1 dimension, 2 × 4, 2 × 6, etc.	Must be suitable and of sufficient strength for all ordinary construction purposes without waste.	$2 cheaper than preceding grade
No. 1 common boards and shiplap, 4 to 12	Must be firm and sound and suitable for use in ordinary construction	Price about the same as above
No. 2 dimension and common	Admits of unsound knots, rotten streaks and other defects. Suitable for cheap and temporary construction.	$3 cheaper than preceding grade
Redwood—		
Clear	Practically free from defects. Sap must not exceed 4% of area of all surfaces	
Sap clear	Can contain sap in excess of 4% of the area of the surfaces	$2 cheaper than preceding grade
Standard	Allows 3–4 sound knots 1¼ inch in diameter or 1–2 sound knots between 1¼–2 inches in diameter	$3 cheaper than preceding grade
Extra merchantable	Sound lumber free from defects which will impair its usefulness. Allows 10% sap on all surfaces	$3 cheaper than preceding grade
Merchantable	60% extra merchantable and not to exceed 40% construction	$3 cheaper than preceding grade
Construction	Allows knots, sap, shake, and other defects that do not impair the strength of the piece	$3 cheaper than preceding grade
No. 3 common	Admits defects that render it unfit for substantial construction work	$3 cheaper than preceding

Hints on Buying Lumber.—It is often more satisfactory for the purchaser of lumber to know the price per piece or per foot than the price per thousand feet. To the average man there is a cloud of mystery surrounding the purchase of a bill of lumber which can be dispelled if he buys it as he would any other commodity. If he knows that a 1 × 12 16-foot stick costs 52 cents, 200 feet of flooring can be secured at 3.2 cents per foot, he has definite prices for definite articles which might not be so well comprehended if the price were given as $32.50 per thousand feet board measure. The prices do not sound as big to the purchaser who feels more at home in figuring the

Fig. 5.—A new type of California bunk-house, 24′ × 54′, with 6-foot porch attached.

cost of a barn or shed. Also he can check his purchase without a lot of figuring, which is a degree of satisfaction. For these reasons, lumber dealers are getting more and more into the habit of selling small lots by the piece or board foot.

In purchasing lumber it is always a good plan to tell the dealer what it is to be used for. His experience should be of assistance in the proper selection of the species, size and grade of lumber best adapted for the desired needs. He will be glad to draw up plans and make out a bill of lumber for the barn or shed which is contemplated. Lumber dealers want their customers to come again. It is not to their interest to allow customers to buy timber which quickly decays for

use in moist places, or to advise too high grade or too expensive wood for protected interior situations.

There is often a tendency on the part of the farmer to use a better grade, or at least a better quality, of lumber than he actually needs. For example, it is because of the large demand for 1×12 boards that the cost of this size is about $4.00 per thousand higher than narrow stock such as 1×8, which would probably serve the purpose just as well.

This rule also applies to the length of the piece since the value of a board increases with its length as well as its width. It is a distinct loss to buy a board 16 feet long and 12 inches wide to saw into pieces 8 feet long and 6 inches wide. Short, narrow lumber is available in all retail yards, and in buying it the farmer will not only save money but also secure a better grade of lumber for the purposes he has in mind.

In many lumber yards there is a "bone pile" which is the respository of broken, warped, checked, rotten, stained and odd pieces of lumber of all kinds. Much of this material is worthless, but considerable good lumber can be secured by the trouble of picking over the pile. Many short pieces can be secured from broken boards, and warped pieces can be cut into shorter lengths so as to utilize much of the material. Weathered boards which have been discolored by exposed to the rain and sun are often discarded because of their appearance. These boards, as well as those affected with blue stain, have not been impaired in strength, and can be readily used about the farm. Another class of material which can be used to advantage for "tinkering" purposes is the short pieces which have been used as car stakes and straps.

One lumber yard in the San Joaquin Valley utilizes much of the defective material which otherwise would go into the "bone pile" by making it up into ready-made articles such as the farmer needs (see Fig. 6). A portable feed rack is made out of lumber for which the company could not get more than $10–$12 per thousand, and the price obtained for it raises the price received for the lumber to a considerable degree. Other articles made out of this low grade lumber are 6×8 hog houses, sections of fencing to go around the hog houses and feed troughs. In the last named article the material for making the trough proper has to be of good material, but the rest of the stock can be of very low grade. The example set by this lumber company should be a pointer to every farmer in his purchase of lumber.

AVAILABILITY OF LUMBER

Softwoods and Hardwoods.—The California farmer has his choice of a wide variety of woods, the greater part being cut from Pacific Coast conifers; cone-bearing trees, with needle or scale-like leaves, such as pine, fir and redwood. The wood produced by conifers is known to lumbermen as "softwood" to distinguish it from that pro-

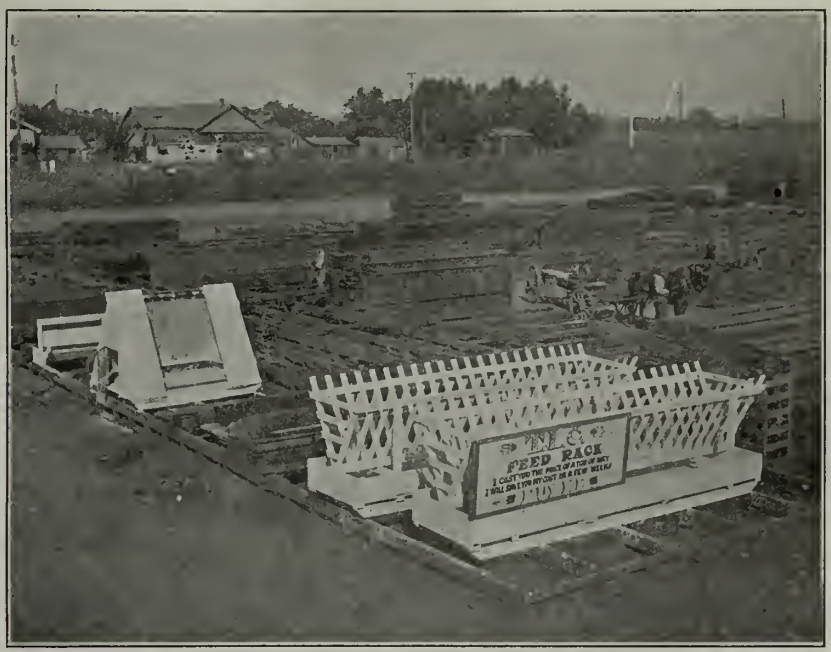


Fig. 6.—Low-grade material is sometimes utilized by retailers to make feed-racks, farrowing pens and other articles needed on the farm.

duced by broad-leaved trees such as oak, hickory and ash, which is called "hardwood." These terms are somewhat inexact since some so-called softwoods like Douglas fir and western yellow pine are harder than some so-called hardwoods such as basswood and willow. In comparison with the wealth of softwood timber in the Pacific coast forests, the supply of hardwoods is very meagre and inferior in quality. A few kinds have some use on the farm, but as a general rule the hardwood material used grows in the eastern states.

THE STRUCTURE OF WOOD

Sapwood and Heartwood.—Wood is made up of very small cells of various sizes and form, more or less closely packed together. These cells are divided into two distinct regions in every tree, called the sapwood and heartwood. The sapwood is the layer of wood on the outer circumference of the tree just under the bark and is generally light in color. The heartwood, which occurs around the pith at the center of the tree, is conspicuous from the sapwood in some woods as red cedar and redwood, because of its darker color. Heartwood is much more durable than sapwood in its natural state, but sapwood can be treated with preservative much more readily.

Annual Rings.—Trees in temperate climates normally add each year a layer of wood which is known as an annual ring. These rings are more marked in trees growing where there are well defined seasons. In eucalyptus, which has no well defined growing season, they are rather indefinite.

Three kinds of sections can be cut in respect to the annual rings.

1. A cross or transverse section is taken at right angles to the height of the tree. It shows the annual layers of growth and the size and arrangement of the cells better than any outer surface. (See Figs. 8, 9, and 10.)

2. A radial section is secured when wood is cut along a longitudinal plane passing through the center of the tree. By "quarter-sawing" is meant sawing along the radius. Lumber cut in this way has what is known as "vertical" grain and makes high-grade flooring because of its wearing qualities.

3. A tangential section results when wood is cut tangent to the annual rings, producing what is known as flat or "slash-grained" lumber. The figure of the wood is brought out to the best advantage by reason of the appearance of the annual rings.

Spring and Summerwood.—Each annual ring is made up of an inner, softer, light colored part formed early in the season which is known as the springwood and an outer, firmer, dark-colored portion which is formed later and which is known as the summerwood. Springwood cells are usually larger in diameter than those formed later in the year.

Medullary Rays.—Besides the wood cells whose length is parallel to the stem, there are other cells which run at right angles to it. In cross-section, these cells, which make up what are known as the medullary rays, appear as whitish lines extending from the pith to the

circumference like the spokes in a wheel. Medullary rays are found in all kinds of trees, but are most conspicuous in such hardwoods as oak and beech where they produce the so-called "silver grain." (See Fig. 9.)

PROPERTIES AND FARM USES OF WESTERN SOFTWOODS

DOUGLAS FIR ("OREGON PINE")

Relation of Strength to Use.—Douglas fir embodies the requisites for a good building wood, inasmuch as it has strength, stiffness, medium weight and is easy to handle and work. Because of these

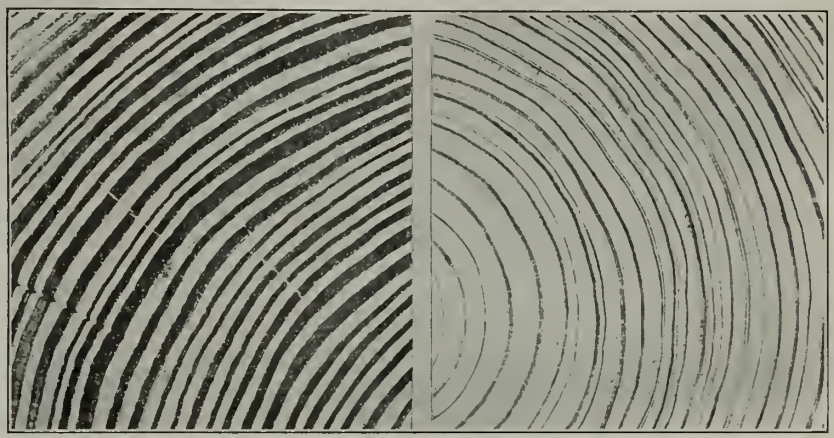


Fig. 7.—Specimens of Southern yellow pine showing relation of density to strength. The section on the left is from a timber having 52 per cent of summerwood and a breaking strength of 11,705 lbs. per square inch. The timber from which the other section was taken had 18 per cent of summerwood and a breaking strength of 7393 lbs. per square inch. (Tests made by U. S. Forest Products Laboratory, Madison, Wis.)

qualities, and especially its strength, which is not exceeded by any wood of its weight in this country, it is the chief wood used on the Pacific coast for structural purposes. Douglas fir is manufactured into all forms of dimension stock and meets the requirements for supporting columns, girders, beams and floors of large buildings of warehouse character, and for joists, studding, rafters, supports and framing lumber of all kinds for houses, barns and other smaller building construction.

The strength of a timber increases in a uniform manner with its weight. Summerwood is much heavier than springwood, hence it follows that the more summerwood a timber possesses, the stronger it

will be. For example, a strength test, made by the United States Forest Products Laboratory, Madison, Wis., on a certain southern yellow pine timber with 52 per cent of summerwood, showed it to be 1.6 times as strong as a piece having only 18 per cent. (See Fig. 7.) After many tests on timbers of varying amounts of summerwood, it was finally concluded that a high-class structural timber could be guaranteed if there were 33⅓ per cent of summerwood present, and the timber were free from injurious defects.

It was determined that the third, fourth and fifth inches on a radial line from the pith (center of the tree) came very close to having the same percentage of summerwood as the average of the whole cross-section of the timber. Hence it was concluded that a timber must show at least one-third summerwood in the third, fourth and fifth inches measured out from the pith to satisfy the strength requirements for exacting purposes. This rule can well be applied in the selection of Douglas fir timbers where much strength is needed, since some pieces have a low percentage of summerwood and are therefore low in strength.

Besides having one-third summerwood, a timber with a high strength value should be solid and free from serious defects such as injurious diagonal grain, loose or rotten knots, wide cheeks, decay or shake between the annual rings. The position of the knots has a great influence on the strength of timber. The most dangerous knots are those located in the bottom quarter of the middle half of the beam (volume 1). The next in order of danger, are those in the upper side near the middle of the span (volume 2), and the least dangerous are those along the center of the line of height (volume 3). Fairly large knots in volume 3 will not seriously affect the strength of a beam, but knots located in volume 1 may reduce its strength value 25 per cent below that of similar beams with knots located in other portions.

There is no grade made at present for Douglas fir which sets aside timbers possessing high-grade structural qualifications, and they must be selected from the ordinary grade of common fir timbers. This grade will usually provide good material for general constructional purposes, but since it includes pieces which vary considerably in density and in position of defects, the stock must be picked over if timbers of high strength value are required.

Use of Proper Grade.—The grades for Douglas fir embrace material just as well fitted for ordinary, every-day uses as for special, exacting ones. The consumer who demands timber that is practically free from defect for every kind of use is not practising good economy. High quality material of all kinds commands high prices, and if the

consumer insists on having the best grades of lumber he must pay what it is worth, just as he would pay an extra price for a choice cut of meat. For example, vertical-grain Douglas fir flooring costs more than flat-grain flooring because of the increased cost of manufacture. It is superior for flooring subject to hard wear since it does not splinter as much and wears longer than flat-grained material, but if the floor is to be carpeted, there would be little advantage in using it.

There are some uses on the farm where only first-class material will do, as for the construction of wood pipes and tanks which require that the staves shall be practically free from defects, but in many cases upper-grade lumber is used when a lower grade will amply serve the purpose. For instance, there is no need of putting as good a grade of material in an implement shed as in a grain storage building, since the building is not subjected to a heavy load as is the case with the granary. All that is necessary is to have the framing sufficiently strong to safely hold the wall and roof covering and to prevent collapse of the building from wind and snow. For this purpose studding of No. 2 dimension would probably prove as satisfactory as No. 1 dimension, and considerably reduce the cost of the building. Another example of the use of a better grade of material than is neeessary is found in the use of high-class sheathing in roof construction. Since all that is required is to have the lumber strong enough to hold shingle nails well, a low grade of sheathing would serve just as well for this purpose at a saving of $3 to $4 per thousand feet.

Use of Creosoted Material.—Objections are often raised to the use of wood, Douglas fir in particular, for sills and foundations, because of its liability to damage by fungi or white ants which may render a timber useless in a few years. The difficulty has been that the wood has not been properly safeguarded against these destructive agencies. All but the most durable woods will deteriorate rapidly when placed in contact with the ground or with stone or concrete foundations. Also, decay is bad at joints and points of contact in any timber structure on account of the water which collects in such places. In such cases the life of the timber can be materially lengthened if the ends are given two coats of hot coal tar creosote. Girders or joists which rest in masonry walls should not be sealed in, but should have an air spaee of at least two inches around the end to allow ventilation.

The brush treatment is hardly sufficient for bridge timbers since the face of the planks would soon be worn away through travel and the action of winter freshets with their loads of driftwood. For this purpose timber thoroughly treated with preservative will give best satisfaction. It was formerly considered that creosoting decreased the

strength of Douglas fir timbers, but a process is now used which is less severe on the fibers of the wood than the original form of treatment. It is now possible to secure a thorough penetration of the wood without causing a material loss of strength.

There is no doubt that the use of creosoted material will greatly increase on the farm as its merits become known. Silo staves of non-durable woods are now being treated. Besides making them more resistant to decay, it renders them less subject to shrinking and swelling. Creosoted wood block is highly successful as a paving material, and there is no reason why its excellent qualities should not make it equally good for dairy-barn floors.

REDWOOD

Durability of Redwood.—If it had no other merits, redwood would deserve a wide use on the farm because of its great natural resistance to rot and fire. Heart redwood when placed in contact with the ground should have an average life of 25 years, whereas some other native woods which could be bought a little cheaper, perhaps, rot out in a few years. When timbers are to be subjected to conditions favorable for decay, only a small amount of sapwood should be used because of its tendency to decay quickly. The heartwood is much more durable, owing to the presence of tannins, oils and resins which make it obnoxious to decay-producing fungi. The durable qualities of redwood should be taken advantage of by the farmer in his choice of wood for such uses as mud sills, flumes, stock tanks, headgates and well casings, where all the conditions promoting decay are present.

Fire Resistance of Wood.—The fire hazard on the farm is high because of the presence of large amounts of inflammable material, carelessness of employees and the lack of fire-fighting facilities. Redwood is particularly well adapted for buildings subject to fire exposure since it is hard to ignite and slow to burn, and fires are easily extinguished. The fire-resistant quality of redwood was well shown at the time of the great San Francisco fire in 1906 when the burned district was fringed with houses built with redwood which resisted the flames until they could be controlled.

Relation of Qualities to Use.—Redwood is light, but relative to its weight it is one of the strongest woods known. It is not especially elastic and consequently is not extensively used for structural purposes where timbers are subject to heavy loads. The wood is sufficiently strong and stiff, however, for general house-construction purposes, and in addition, is light and durable. These properties, as

well as its ability to keep its shape, make redwood especially valuable to poultry men, since it is essential that the joints in incubators and other poultry yard appliances resist rot and keep tight in all kinds of weather.

Redwood is an excellent wood for silos because of its durability, small amount of shrinkage and non-conducting properties. A redwood stave silo should last at least 20 years, and for its cost, is very economical as compared with that built of other materials. Although not as good as a stave silo, the resaw silo made of 6-inch redwood boards, nailed horizontally to upright 2 × 4 Douglas fir studdings with several layers of building paper placed between, or the wood-hoop silo,[4] has served many a California farmer very acceptably.

Wood pipe made from redwood or Douglas fir has many advantages as compared to cast-iron pipe for conveying water for irrigation. It is not so subject to injury from chemicals in the soil and does not readily expand or contract due to extremes of temperature. Also, repairs can be made quickly and cheaply. Wood stave pipe can be made smaller than that of other materials, since the low internal friction of the smooth inner surface permits the passage of a greater volume of water per unit of sectional area. Untreated Douglas fir is less durable than redwood when placed in the ground under conditions favoring rot. If treated with creosote, however, Douglas fir will equal redwood in durability and where high pressures are exerted its superior tensile strength gives it the preference. The average life of a wood pipe, when continually filled with water, is estimated by engineers to be about 25 years. Cases have been known where redwood pipe placed in contact with the soil has lasted fifty years.

Redwood makes a good shingle wood because of its durability and the slowness with which it burns. Zinc-coated or cut iron nails should be used, due to the tannin in the wood which quickly corrodes the ordinary shingle nail. If properly laid, a vertical grain No. 1 clear redwood shingle roof should last from 25 to 40 years. Redwood shakes, which are either sawed or split shingles, commonly 36 inches long, 6 inches wide and ¼ inch thick, without taper, are widely used in California for sidewall coverings of buildings because of the distinctive appearance which they give. Several different sizes can be had, the split shakes being considered superior to those that are sawed, because of the straightness of the grain.

Use of Proper Grade.—The upper grades of redwood, comprising clear, sap clear, and standard, come in lengths of from 8 to 20 feet

[4] The Construction of the Wood-Hoop Silo, Cir. 173, Agricultural Experiment Station, University of California, 1917.

and in widths from 3 inches up, command much better prices than the common grades which admit of a much higher percentage of defect. For ordinary uses about the farm, the common grades with the same range of widths and lengths are the most economical. Short, narrow lumber can be obtained in all grades, and is cheaper and better than the usual sizes for which custom has created a heavy demand. For example, barn rustic made from 1×8 inch boards is just as good and is from \$3 to \$5 per thousand cheaper than that made from 1×12 inch boards. Short pieces of clear lumber are from \$5 to \$7 per thousand cheaper than 12- and 14-foot lengths of the same grade. The construction grade is designed for ordinary construction purposes, and is free from defects which materially weaken the piece. Well-seasoned redwood of the extra merchantable grade is the best material to use for flumes and irrigation boxes. In their construction much short lumber can be used and the expense considerably reduced. The lowest grade of redwood, No. 3 common, is not well adapted for substantial construction work on account of its defects, but it can be used to advantage for subflooring or sheathing. For silos and tanks only the best grades of clear redwood should be used.

BIGTREE

The wood of the bigtree is lighter and more brittle than that of the coast redwood, to which it is inferior in practically all respects except durability. Bigtree is cut into lumber to some extent, but its chief value is for posts, shakes and stakes for vineyards in the San Joaquin Valley. From one tree 14 feet in diameter, there were cut 12,000 $2 \times 2 \times 7$ grape stakes, 6,500 $4 \times 5 \times 7$ posts, and 15,000 shakes, 2 feet long and 6 inches wide, the total value of the product being nearly one thousand dollars. The use of this wood is local, and it is mentioned only to distinguish it from the coast redwood, with which it is often confused.

WESTERN YELLOW PINE ("CALIFORNIA WHITE PINE")

Relation of Properties to Use.—Western yellow pine is advertised under the name of California white pine to convey the idea that it is in a class with the eastern white pine and sugar pine for finishing and factory material. Botanically, western yellow pine is classed with the hard or "yellow" pines, rather than with the soft or "white" pines, but this wood varies in its characteristics, depending on the character of the trees from which it is cut. Lumber cut from the smaller trees, commonly called "bull-pines," and out from the centers of the larger trees, is coarse-grained and rather resinous, resembling that

of the southern yellow pine. That cut from the outside of the larger trees is soft, uniform-textured and resembles the white pine in its characteristics. Much of the western yellow pine timber cut in California is so soft and white that it is used for the same purpose as the true white pine. In addition to being a widely used wood for doors, sash, finish, ceiling and flooring, western yellow pine serves admirably for general construction purposes throughout its range. It is extensively used for fruit boxes and drying trays because of its lightness, strength and ability to keep its shape.

Many of the retail yards in the Sacramento and San Joaquin valleys are stocked chiefly with timber cut in the Sierras, a large part of which is western yellow pine. The common grades of pine boards are made up of this species and sugar pine, and usually are sold under the name of mountain pine. This lumber is well adapted for all uses except those requiring special strength and durability. Mountain pine dimension material includes white fir in addition to these species, and sells at retail for a little less than Douglas fir, to which it is considerably inferior in strength and elasticity.

Use of Treated Posts and Poles.—Farmers in the foothills of the Sierras could utilize second-growth western yellow pine to good advantage for fence posts and telephone poles in case the butts were treated with a preservative. The wood is sufficiently strong for these purposes, but in its natural state it is lacking in durability. Round posts, such as can be cut at little expense from second-growth stands of western yellow pine, are well adapted for preservative treatment since they are largely sapwood, which takes preservative readily.

A fair estimate for the cost of an untreated pine post in the ground is 14 cents, compared to a cost of 25 cents for a treated post. The untreated post lasts only about five years and the treated post twenty years. When the interest and cost of replacement is figured for these periods, it will be found that the yearly cost of the treated post is about half that of the untreated post. The life of first-class redwood or cedar posts, which sell for 20 to 25 cents, does not exceed 20 years, and if the posts are sappy or the soil sandy, a much shorter life must be expected. As a general rule, a farmer with a plentiful supply of a non-durable timber, like western yellow pine, and a simple treating plant can save money in the long run over the cost of untreated posts of durable species.[5]

[5] A recent Farmers' Bulletin, No. 744, entitled "The Preservative Treatment of Farm Timbers," by Geo. M. Hunt, gives the kind of equipment needed and the method of treatment of different classes of timber on the farm. The bulletin may be obtained free of charge from the Editor and Chief of the Division of Publications, U. S. Dept. of Agriculture, Washington, D. C.

High-grade creosote oils suitable for treating farm timbers can be obtained through local dealers in gallon cans up to 25-gallon barrels at a cost of from 60 cents to 85 cents per gallon, depending on the quantity ordered. A barrel of good creosote is a good investment since the oil can be used to advantage for the treatment of any cheap, non-durable wood.

It is always a good plan to treat sills and foundation timbers in contact with the ground or with concrete foundations. Lumber used in greenhouses is usually subject to rapid decay, which can be greatly retarded by preservative treatment. Except where naturally durable woods are available, a preservative treatment will always prove economical for timber exposed to moisture and decay.

SUGAR PINE

Sugar pine is considered the most valuable tree on the Pacific Coast, due to the excellent qualities of the wood and the amount of high-class lumber which can be obtained from it for finishing and remanufacturing purposes. The qualities which especially commend it to the artisan are the ease with which it can be worked and the slight shrinkage, swelling, and warping which takes place under varying atmospheric conditions. From 40 to 50 per cent of the cut consists of the upper grades, No. 2 shop and better, the greatest part of which is used for finishing purposes, and the manufacture of sash, doors, blinds, pattern stock and other special uses. In some parts of central California, sugar pine is used as a lining material for silos, for which use its appears well adapted because of its durability and ability to keep its shape.

Sugar pine is a favorite box material on account of its softness, lightness, light color, freedom from odor and taste, and because it can be nailed without splitting. A large proportion of the lumber included in the grades below No. 2 shop is made into fruit boxes, the balance of the lower grades being found in yards supplied by mills operating in the Sierras in the form of common boards and dimension material. Sugar pine is not as durable in contact with the ground as redwood or cedar, but in the air it shows great lasting properties. When handled by retailers, the lower grades are often included in the combination of woods known as mountain pine. Although poor in shock-resisting ability sugar pine is strong enough to be used for purposes where only moderate strength is required.

The early settlers in the Sierras found sugar pine well adapted for shakes, and the fruit men in the valleys below soon found out

its suitability for raisin and fruit trays. At first all this material was split out of straight-grained trees, causing much waste of material, but now it is principally sawed out by small shingle or tray mills.

THE TRUE FIRS

There are three distinct species of true firs found in California which are more or less used on the farm. They are white fir and red fir, which grow in the Sierras, and lowland fir, which is found in the coast forests.

In the San Joaquin Valley considerable white fir is included in the grade of mountain pine. In a dry climate, it serves for cheap and temporary construction purposes, but it is not satisfactory when strength and durability are sought. Because of its tendency to split when nailed, it has but a limited use in the manufacture of fruit boxes, which are chiefly made of pine. Red fir is not extensively cut into lumber on account of the altitude at which it grows. It is stronger and much more durable than white fir and finds a ready use on mountain ranches in localities in which it grows.

Retailers who handle lumber cut in the coast region generally carry a common grade of white fir which grows there, which sells for about $3 less per thousand board feet than a similar grade of other species. This wood is neither durable nor strong, and has a tendency to warp and check, but it fulfills a certain need for cheap, temporary construction and for forms. A large part of the cut is made into a wall board which is different from the ordinary wall board made of wood pulp, in that it has a wooden core made firm by layers of cement surfaced with heavy paper. This makes a dry, sanitary and clean lining for walls and ceilings, and is especially good for remodeling the interior of buildings, since it can be quickly and easily applied.

PORT ORFORD CEDAR ("WHITE CEDAR")

Port Orford cedar is a comparatively new wood in California, but it is rapidly growing in favor for farm use because of the combination of strength and durability which it possesses. The strength is due to the compact character of the wood, and the durability to the presence of an oil in the wood which gives it a very distinctive odor. It is a popular belief that this odor will repel insects and it is extensively used in closets and chests. The wood may act in this capacity when freshly cut, but it soon loses this quality as it dries out and loses its scent. Port Orford cedar, however, has sufficient excellent qualities to recommend it without that of being a repellent to insects.

Besides being strong and durable, Port Orford cedar is easily worked, keeps its shape and does not splinter under long and hard wear. These properties make it an excellent wood for underpinning, bridge material, barn boards, fencing and other purposes where a wood is required that will resist decay and yet be strong and wear well. The grade of common, which retails at from $25 to $30 per thousand feet, depending on the sizes desired, furnishes a tight-knotted material that is highly satisfactory for ordinary construction work on the farm. A cheaper grade, No. 3 common, which admits of larger and coarser defects, but not sufficient to prevent the use of each piece in full length and full widths for ordinary purposes, can be purchased for from $20 to $22 per thousand in yards carrying this wood. The upper grades of Port Orford cedar have a wide use for finishing material and command prices equal to those of any of the western softwoods.

WESTERN RED CEDAR

Western red cedar is the most widely used shingle wood in the United States because of its lightness, slight shrinkage and expansion, durability and the ease with which the wood will take nails without splitting. It makes a roof that is not affected by weather conditions and which can be cheaply constructed and maintained. More trouble with shingle roofs has been experienced in the past due to poor construction and the use of improper nails than to any fault in the wood itself. Shingle manufacturers have met this difficulty by getting out a complete set of directions on the correct methods of laying shingles so as to insure a tight and durable roof.

For permanent construction only the higher grades of shingles, such as retail for about $3.50 per thousand, should be used. The best method of selecting shingles is by a trademark bearing the guarantee of the manufacturer. This indicates that the shingles have been inspected and hold true to specifications as regards sap, thickness, size and grain. A grade of shingles well suited for farm use requires that all the shingles be free from sap and that 80 per cent be free from defects. Only dry shingles should be used if they are to be stained. Shingles that are not to be stained should be wet thoroughly before laying.

Western red cedar has an extensive use as grape stakes for which redwood was used almost entirely a few years ago. The wood is well adapted for this use on account of its lightness and durability, and generally undersells redwood several dollars a thousand stakes.

There is relatively little red cedar lumber handled by retailers in California, but where available, it is used for the same purposes as redwood.

INCENSE CEDAR

Incense cedar is found chiefly on the west slope of the Sierra Nevada Mountains in California, where it forms about 8 per cent of the stand. It is cut into lumber only to a limited extent because of the prevalence of "dry rot," the result of a fungus which attacks the heartwood, causing cavities which become filled with a dry, brownish substance that gives the name to the defect. Other names given the tree are red cedar, white cedar and post cedar.

Incense cedar is one of the most durable woods in the Sierras, the heartwood being extensively used by mountain ranchers for posts, poles and rails. Also it has a wide local use for stubs for poles of less durable species. When so used, it is set in the ground alongside the pole to which it is wired or bolted. It is usually the custom to split out timber for these uses, the value of the finished product averaging 16c to 18c for posts, $1.25 to $1.50 for poles, and 30c for stubs. It is estimated that the life of heart cedar for these purposes is from 20 to 25 years.

Occasionally it is possible to obtain incense cedar logs which are not affected with dry rot, and when this is the case, lumber of high quality can be secured. The small quantity of high-grade lumber obtained is used locally for outside trim and interior finish. The bulk of the material sawed out is for dimension stuff and rough construction work, such as sills, culverts and bridge plank, for which it is adapted because of its durability and wearing qualities. The grade of lumber used for these purposes is No. 1 and 2 common, which sells for from $20 to $27 per thousand in the local mountain markets. The grade lower than No. 2 common is generally so badly affected with dry rot that it is of little value, and sells for as low as $8 to $10 per thousand. The prohibitive cost of transportation and the relatively small quantity cut keeps this wood from competing with the coast redwood in the Sacramento and San Joaquin valleys and it finds little use there except in a small way for grape stakes and raisin trays.

WESTERN HEMLOCK ("SILVER FIR")

There is considerable unfounded prejudice against this wood, which is partially due to the poor reputation of eastern hemlock, which is a very splintery, coarse-grained wood, and much inferior to the western species. It also gained a bad name because it was formerly

the practice for retailers to buy green lumber, with the result that deterioration took place in the yards in the seasoning process. The poor appearance of the lumber contrasted with that of the seasoned stock of other species made a poor impression on the average consumer.

If well seasoned, western hemlock makes a good wood for purposes where it is not exposed to the weather, as for the lining of granaries, since the wood is light, non-resinous, fairly strong, tough, close-grained and holds nails well. It is not a durable wood, however, and should not be placed in contact with the ground. Much of the higher grade material is made into ceiling which has considerable use in some localities, since it is cheaper and serves the purpose as well as some other species in the market. The same grades are made for hemlock as for Douglas fir, but it undersells that timber from $2 to $3 per thousand feet, chiefly because of the prejudice against it which still exists.

PROPERTIES AND FARM USES OF HARDWOODS

The use of hardwoods on the farm is necessary for the repairing of farm implements, such as harvesters and wagons, and for other purposes, such as handles, spokes and poles, where special strength and toughness are required. Eastern woods such as oak, ash, hickory and maple are generally used, the native hardwoods being little used except in remote localities. They are rarely sawed into lumber, the practice being to rough out the pieces required and allow them to season before making them up into the articles for which they are intended.

The California oaks, of which there are a number of species, such as white oak, black oak, live oak and tanbark oak, find little use except as fuel. The old timber is generally too brittle and weak for purposes where strength is required, and it is only the young growth which has the necessary qualities for the needed purposes. Eastern white oak is stronger, harder and tougher than red oak or Japanese oak and is probably the most widely used of all hardwoods.

California laurel is a native hardwood the worth of which people have been slow to recognize. It is heavy, hard and strong, and will do the work of most hardwoods at a considerably lower cost. It is extensively sold to country trade by certain hardwood dealers in San Francisco for wagon bottoms, the price ranging from 6c to 9c per foot, depending on the width and thickness of the piece. The average range of prices for eastern oak is from 11c to 15c and for Japanese oak, 9c to 14c per foot. It has an extensive use for house

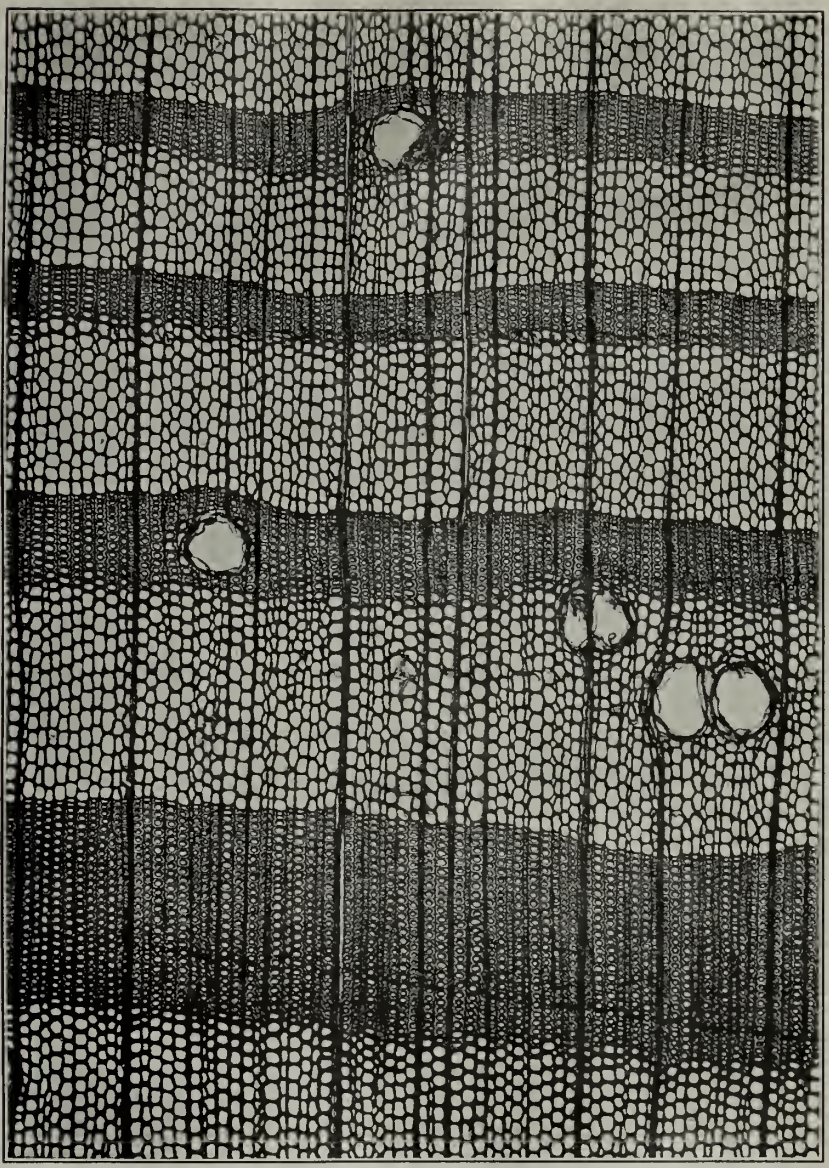


Fig. 8.—Longleaf pine, a non-porous wood. Cross-section showing several annual rings. Pores are absent and the structure is very uniform, due to the similar structure and arrangement of the wood elements. The growth rings are defined by the greater density of the summerwood. The larger openings seen are the resin ducts. The medullary rays appear as fine black lines.

rollers on account of its strength in compression, which is greater than that of oak.

Several species of the Australian genus Eucalyptus have been planted in California; extensive areas of blue gum having been set out with the idea of producing lumber in a short period of time. It has been well demonstrated, however, that satisfactory lumber can be obtained only from carefully selected large trees, since the wood from the small trees seasons so rapidly that excessive checking and warping takes place. The wood is very tough, hard and strong and is well adapted for small articles such as tool handles, brackets and insulator pins. A manufacturer of these articles is of the opinion that eucalyptus should displace 80 per cent of the eastern hardwoods used for these purposes.

In its natural state eucalyptus will not make a satisfactory post because of the rapid rate of decay of the sapwood. If treated with creosote by the open-tank method, however, the posts should give as good service as those of any other wood. A wide and very satisfactory use of eucalyptus is for fuel. Thoroughly seasoned wood compares favorably with oak in heating value, and where available, costs considerably less.

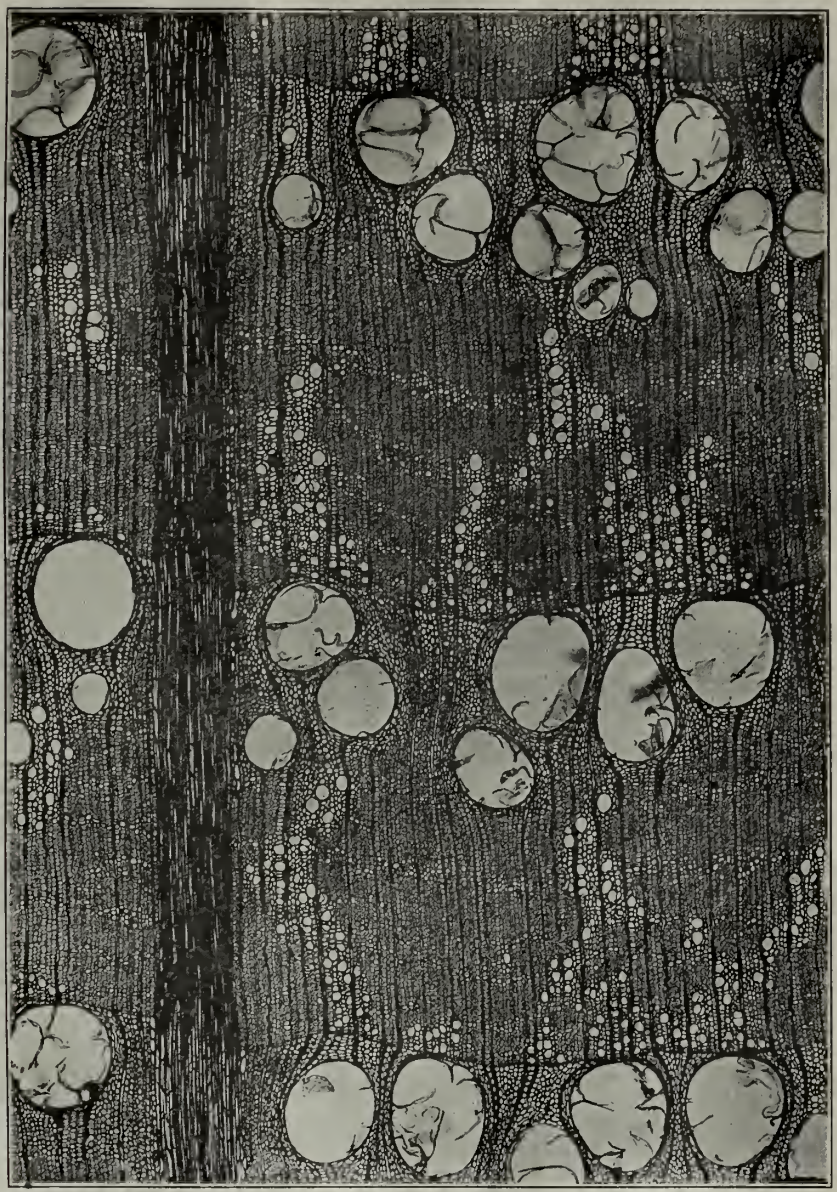
KEY FOR IDENTIFICATION OF WOODS COMMONLY USED BY CALIFORNIA FARMERS

The purpose of this key is to arrange the main facts pertaining to the principal woods used by California farmers in such a way that they may be readily identified. The following terms, in addition to those already given, are used in connection with this key:

Pores or Vessels.—If the end of a piece of oak is examined, small holes called pores can be seen. These are cross-sections of small hollow tubular structures which serve to conduct the sap up the tree. These pores are found only in hardwoods, consequently softwoods are classified as "nonporous woods." (See Fig. 8.)

Ring Porous.—When there is a considerable difference in size between the pores in the springwood and summerwood, and the large pores are located in the springwood so that they form conspicuous concentric circles, as seen in the cross-section, the wood is said to be "ring porous." (See Fig. 9.)

Diffuse Porous.—If the pores are scattered throughout the annual ring and there is little difference between those in the springwood and those in the summerwood, the wood is said to be diffuse porous." (See Fig. 10.)



* Fig. 9.—White oak, a ring-porous wood. Cross-section through two annual rings. Large pores of spring wood are shown on lower portion of each growth ring. The small pores of the summer wood are in fan-like groups. Note large medullary ray to the left extending at right angles to the growth rings. Wood structure is complex, due to the lack of uniform structure and arrangement of the elements.

* Forest Service photo, Forest Products Laboratory, Madison, Wis.

Resin Ducts.—It may appear that in some of the conifers such as Douglas fir and pine, pores can be seen in cross-section. The small openings which appear, however, are cross-sections of canals which contain the resin produced by these species and are known as "resin ducts." They are absent in some softwoods, like cedar and redwood, and are never found in hardwoods. (See Fig. 8.)

SUGGESTIONS FOR USING KEY

1. Cut a smooth cross-section from the end of the piece of wood under examination. The knife should be very sharp, since details of structure cannot be well observed if the surface is rough.

2. A magnifying glass of some kind, such as the ordinary hand lens, is of much assistance in bringing out the structural details of wood.

3. Softwoods can be distinguished from hardwoods by keeping in mind the following points:

Softwoods	Hardwoods
a. Medullary rays not conspicuous.	*a*. Medullary rays generally conspicuous.
b. Some are resinous.	*b*. None are resinous.
c. Non-porous.	*c*. Pores present.
d. Easy to cut, as a rule.	*d*. Hard to cut, as a rule.
e. Wood generally light when dry.	*e*. Wood usually heavy when dry.

4. The nature of the change between spring and summerwood, whether abrupt or gradual, is an important distinguishing characteristic in softwoods.

5. Some woods, such as redwood and bigtree, can be readily recognized by their color.

6. The smell of the wood is sufficient to distinguish the cedars. Moistening the surface brings out the odor more distinctly.

7. The pores in hardwoods should not be confused with the resin ducts in some of the conifers. The presence of resin can be detected by resinous exudations on the surface. Resin ducts often appear as brownish lines on longitudinal surfaces of dry lumber.

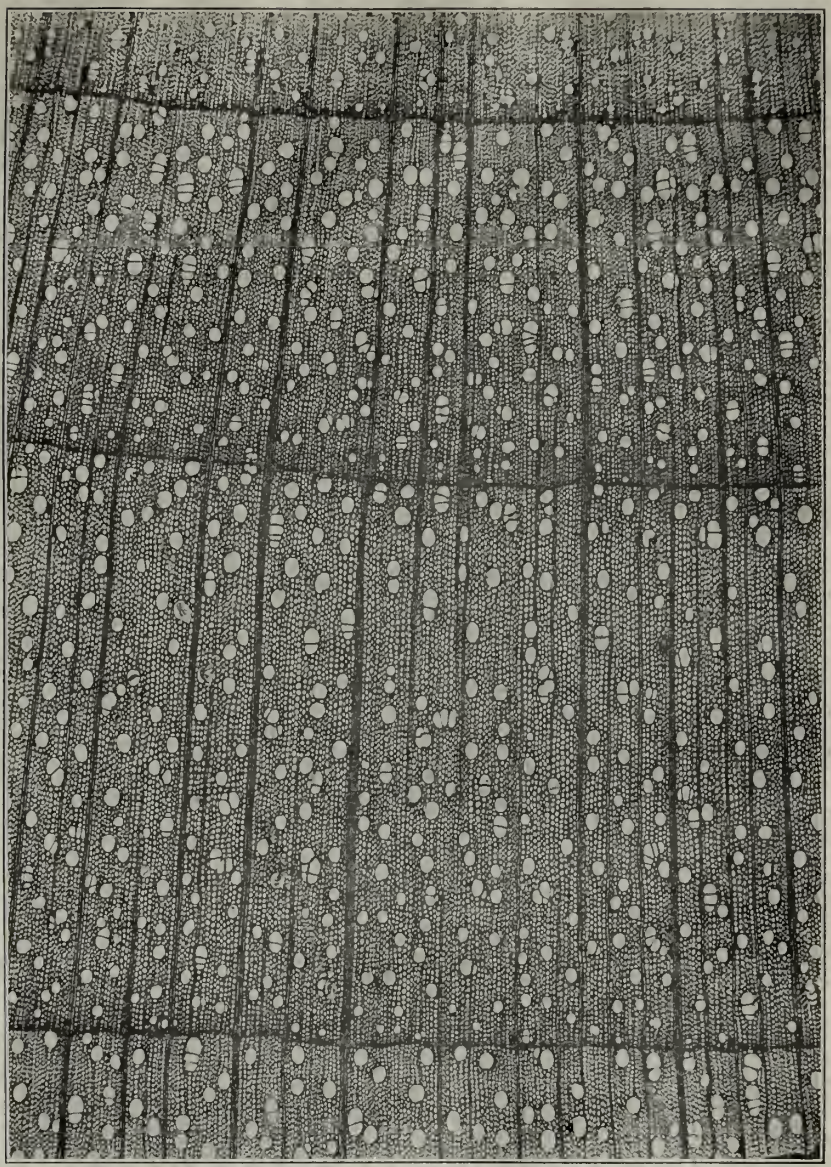


*Fig. 10.—Hard maple, a diffuse-porous wood. Cross-section through two annual rings. The pores are small and uniform in size in both spring and summer wood. The summer wood can be recognized by its greater density. The medullary rays are small, but quite distinct.

* Photos 8 and 10, Forest Service.

Key for Woods Commonly Used on California Farms

I. Pores absent—*Conifers.*

A. Abrupt change between spring and summerwood.

1. Resinous.

a. Cross-section has appearance of cut-horn. Dark summerwood reddish in color. Wood moderately heavy. *Douglas Fir.*

b. Cross-section not horn-like in appearance. Heartwood reddish brown and darker than sapwood. Wood moderately light, some pieces only slightly resinous. *Western Yellow Pine.*

2. Non-resinous.

a. Color a dead white. Wood crumples under the knife in cross-section. Freshly cut pieces have strong, rancid odor. Wood checks and splits very easily. *White Fir.*

b. Color light brown. Wood cuts evenly in cross-section. Fresh pieces have sour odor. Takes nails well. *Western Hemlock.*

B. Gradual change between spring and summerwood.

1. Odorous.

a. Color white. Little change in color between sapwood and heartwood. Wood has strong, spicy odor and taste. *Port Orford Cedar.*

b. Color of heartwood light brown, sapwood whitish. Grain fine and uniform. Wood generally "pecky" due to dry rot. Faint aromatic odor. *Incense Cedar.*

c. Color reddish-brown. Wood rather coarse-grained. Agreeable odor, peculiar to cedar shingles. *Western Red Cedar.*

2. Odorless.

a. Color creamy white. Brown lines due to resin ducts found on radial and tangential surfaces. Wood of fine texture. *Sugar Pine.*

b. Color of heartwood red. Sapwood white and very narrow. Wood of coarse texture. *Redwood.*

c. Color of heartwood pinkish. Wood very light in weight. *Bigtree.*

II. Pores present—*Hardwoods.*

A. Ring porous (zone of large pores collected in springwood of annual ring).

1. Medullary rays large.

Large pores in 1–3 rows in springwood; change to smaller pores of summerwood abrupt. Wood heavy and hard. *White Oak.*

2. Medullary rays small.

a. Large pores in broad zone in springwood. Pores in summerwood small, scattered singly or in groups of short broken lines. Surface of wood light with a fine brown marking of lines running parallel with the grain. *White Ash.*

b. Large pores in springwood irregular, extending more or less into summerwood. Fine lines (not of pores) in summerwood extending parallel with the annual rings. Wood heavy, tough, hard and strong. *Hickory.*

B. Diffuse-porous (pores scattered uniformly throughout annual ring).

1. Annual rings absent or indistinct.

a. Rays very fine. Pores distributed in many lines. Color light brown. Wood very hard and tough. Interlaced fibers make it difficult to work. *Blue Gum.*

b. Rays fine but distinct. Pores occur singly or in small groups. Color pale white with dark streaks at intervals. Wood very hard and tough. Odor aromatic, taste peppery. *California Laurel.*

LIST OF CIRCULARS DEALING WITH WESTERN SOFTWOODS

Douglas Fir.

Portland Lumber Co., 16 California st., San Francisco.
"Prosperity on your Dairy Farm."

West Coast Lumbermen's Association, Seattle, Wash.
"Creosoted Wood Stave Pipe for Irrigation Purposes."
"Creosoted Douglas Fir Paving Blocks."
"Creosoted Douglas Fir Road Culverts."
"Creosoted Fence Posts and Poles."
"Facts about Paving Bridge Floors."
"Lumber Users' Guide No. 8" (general description of Douglas fir).

Redwood.

California Redwood Assoc., 713 New Call Bldg., San Francisco.
"California Redwood on the Farm."
"The Test by Fire."
"Two Births."
"California Redwood Lives Forever."

Pine.

California Sugar and White Pine Co., San Francisco, Cal.
"California Sugar and White Pine."

Port Orford Cedar and Hemlock.

Information may be obtained from Coos Bay Lumber Company, Oakland, Cal.

Western Red Cedar.

West Coast Lumbermen's Association, Seattle, Wash.
"Lumber Users' Guide No. 12" (general description of Western Red Cedar).
"Farm Buildings of Red Cedar Shingles."
"Bungalow Houses of Red Cedar Shingles."
"Boys' Builder and Garage Book."

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